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REINFORCEMENT VARIABLES IN THE CONTROL OF UNIT READING RESPONSES[1]

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The present study was concerned with the effects of schedules of reinforcement upon the rate of verbal responding to written material in children. Four multiple schedules were used; multiple CRF-EXT, multiple CRF-VR, multiple CRF-VI, and multiple VR-VI, one subject being run on each schedule. Rates under CRF were lower than under VR, and somewhat higher than under VI, and much higher than under extinction. The subject run on multiple VR-VI showed little rate difference in the two components.

The first author and his associates have undertaken a systematic experimental analysis of the acquisition of reading behavior (Staats, in press). A preliminary experimental procedure was devised and the effect of extrinsic reinforcers (edibles, tokens, and trinkets) on the maintenance of reading behavior was explored (Staats, Staats, Schutz, and Wolf, 1962). The results indicated the potential productiveness of operant conditioning principles and procedures in the study of this type of behavior.

Additional areas of development were suggested by the above results. For example, a continuous record of reading responses was introduced to provide a more sensitive measurement of the effect of experimental variables. Further, a more controlled procedure for the presentation of textual stimulus units was constructed so that the program itself did not impose strong characteristics on the record, thus obscuring the effects of other independent variables. Finally, a system of reinforcement was devised for use with pre-school subjects to maintain good working behavior for the long period necessary to study reading acquisition.

Using these developments, a study was conducted in which three 4-year-old children were run in 20-min training sessions. The children continued the training until the experiment was suspended. In two cases, the training extended for 40 sessions with behavior remaining strong to the end (Staats, Minke, Finley, Wolf, and Brooks, in press). The present study begins an exploration of the value of the materials, apparatus, and general procedure for producing reliable results relating independent variables to the dependent variable of reading acquisition, *i.e.*, the effect upon reading rate of the manipulation of various reinforcement schedules, using multiple schedule techniques.

METHOD

Subjects

Four, 4-year-old children (three boys, one girl), who would be entering kindergarten at the Arizona State University Campus Laboratory School the following fall semester (1962) were volunteered for participation by their parents. The female *S* failed to exhibit the requisite behaviors after the pretraining period and was replaced by a male *S* from the same population. The experimenter transported the children to and from the Language Learning Laboratory.

Materials and Apparatus

The reading characters consisted of letters and letter combinations presented on 5 by 8 in. index cards. These characters were introduced and repeated in the program, one at

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a time, according to a complex circuiting formula. No character was ever completely dropped from the program. The appropriate character was typed in lower case primary letters. Below it, in randomly assigned positions, appeared one matching and two nonmatching characters.

The apparatus (see Fig. 1) for presenting the reading characters consisted of a vertical panel containing a small plexiglass window and three similar windows centered below it. The panel was mounted on a table in front of *S*; a slight push on each window activated a microswitch. The printed portions of a program card could be viewed through the windows. Beneath each of the lower three windows was a corresponding button, and a press of the button below the correct window activated a marble dispensing device. A door-bell-type pushbutton was on the table in front of *S*.

The reinforcer system constructed to maintain *S*'s behavior is also schematized in Fig. 1. Correct responses were reinforced with marbles delivered into a small box by a marble dispenser located at *S*'s right. The *S* could place the marble reinforcer into the funnel over the dispenser and receive a plastic trinket,[3] a small edible, or a penny from a Universal Feeder to the left. Or, *S* could place a marble in one of four clear plexiglass tubes located in a row on a low shelf at his extreme right. Each tube could hold a different number of marbles: 10, 35, 80, or 150. Above each tube a toy, which *S* had previously selected, was displayed. When the tube was filled, *S* received the toy above the tube. Toys were selected before the experimental session from four bins in another room. Each bin contained toys of approximately \$0.10,[4] \$0.35, \$0.80, or \$1.50 value.

The automatic contingencies and recording were handled by standard operant conditioning apparatus. A Gerbrands cumulative recorder recorded *S*'s responses, the delivery of a toy, and the operation of the Universal Feeder. Recorder's paper speed was 15 cm per hr and each response double-stepped the recording pen.

Occasionally, the automatic equipment would malfunction during a daily session, causing a brief interruption. At such times *S* was taken from the experimental chamber to a playroom containing a hobby-horse.

Procedure

The reading task consisted of a complex chain of responses whenever a reading character was involved to which the *S* had not already acquired a reading response. This task required that *S* first be introduced to a pretraining procedure in which the chain was acquired.

The reading task was designed to insure that *S* said the name of a reading character while looking at it, the basic definition of a correct response. Looking at the stimulus while saying its name was required by having a matching task in the chain. The first response of the *S* was to press the door-bell (see Fig. 1). This resulted in the appearance of the reading character in the top window, and of that character and two others in the windows below. Ten seconds later, *E* said the name of the character. The *S* was required to echo this name, press the plastic cover on the top window, repeat the name, find the matching character in the one of the three lower windows, and then press its cover. Finally, pressing the button below this window completed a correct response (chain). Thus, this type of correct response included looking at the reading character, saying its name twice, and several button or window pressing responses.

Since the reading characters were presented more than once, however, it was frequently possible in the reading task for *S* to look at the letter and say its name without waiting for the auditory prompt. This fits the basic response definition. Without requiring the matching and pressing responses, this response was also treated as correct, *i.e.*, the stimulus card was withdrawn, and if the schedule called for it, a marble reinforcer was delivered.

When an incorrect response occurred—either vocally or in matching the reading characters—a buzzer was rung and *E* presented the auditory stimulus which named the character. The

[3]The trinkets employed were small plastic rings, stars, balls, tools, shoes, utensils, cups, tops, coins, etc., distributed by the Paul A. Price Co., Inc., 55 Leonard Street, New York 13, N. Y.

[4]Included among the \$0.10 items were a number of miniature products such as boxes of tissue or aluminum foil, picnic coolers, soft drink bottles, model rockets, straws, games, *etc.*, which were provided by Merry Manufacturing Company, 531 N. Wayne Avenue, Cincinatti 15, Ohio.

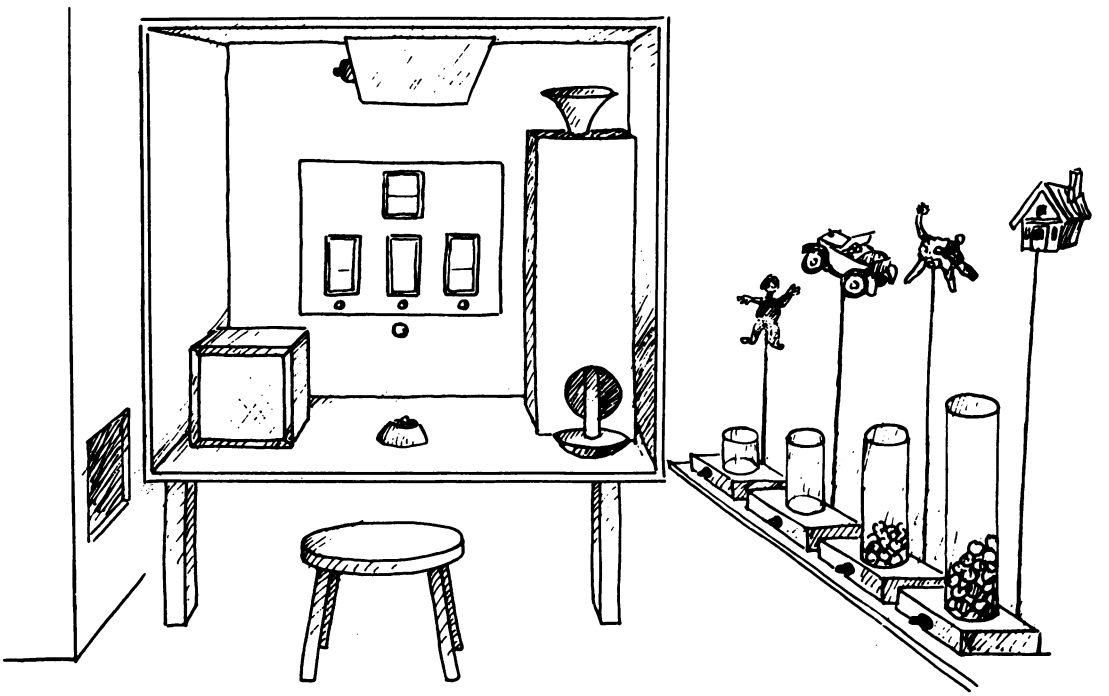

Fig. 1. The laboratory facility for the study of reading acquisition.

S was then required to go through the complete chain of echoing and matching responses.

Thus, three different contingencies were possible. Naming the stimulus in the top window spontaneously resulted in immediate reinforcement. When he did not do this he was prompted to name the stimulus and complete the chain. Thirdly, an error required the *S* to return to the echoing phase of the chain and then to finish the chain correctly. In this way, only correct vocal responses while looking at the reading character were reinforced.

Before starting the reading task proper, each *S* received pretraining designed to establish the appropriate responses. An echoic task (consisting of single vowels and words) was presented initially, in which *S* was required to make a matching vocal response to the vowel or word spoken by *E*. This established echoic control.

Then, 30 matching-to-sample cards, made up of line drawings of simple objects, were used to establish the chain of echoic, matching and pressing responses described above. After this chain was established, *S* was instructed to "anticipate," if possible, the name of the picture in the upper window before *E* provided the verbal stimulus. Correct anticipations were immediately reinforced in the manner described above.

When *S* had learned to give picture responses without prompting, the reading task proper began and the matching-to-sample cards for the reading characters were presented. Two *S*s displayed some breakdown in the response chain when the reading materials were introduced; occasional prompting of the appropriate chain behaviors was maintained for them for the first few sessions.

During the pretraining phases, each correct response of the *S* was reinforced with presentation of a marble. From the time the actual reading task was introduced, however, each *S* was run under a different two-component multiple schedule involving non-reinforced responses. The four different multiple schedules were: CRF-EXT, CRF-VR, CRF-VI 2 min, and VR-VI 2 min. It was initially decided to begin the variable ratio at a VR 6, but as the experiment progressed it became obvious that the ratio was too high. Therefore, it was dropped to VR 2 and raised gradually to VR 6 only after the response rate became somewhat stable under VR 2.

The change of component under the multiple schedule was effected on a reinforcer-contingent basis for CRF and VR components,

and on a time-contingent basis for VI and EXT components. The CRF component was in effect for 15 reinforcers, and the VR component for five. The VI schedule was in effect for 10 min, and the extinction component for 5 min. Each session was terminated after 20 min, regardless of which component was in effect and regardless of the length of time that the component had been in effect. Each *S* was slated to run for 30 sessions.

Each component of a multiple schedule was correlated with an illumination condition in the experimental room. Under one condition both the light over the apparatus panel and the overhead room lights were on; under the other condition the overhead room light was off. All CRF conditions, as well as the VR component in the *mult* VR-VI condition, were correlated with the panel-light-only condition. The second component of the multiple schedule was correlated with the panel-plus-room-light condition. During pretraining, an intermediate light condition prevailed which consisted of the panel light and a wall light, but not the room light.

The *S* was allowed to consume the edibles obtained during the session or he could take them home. When one of the plastic tubes had been filled, the small bulb at the tube's base lighted momentarily, the bell rang and the light flashed in the marble dispenser. The cumulative recorder stopped, the toy was given to the child, and the marble tube was emptied. A new toy was then mounted above the tube, and the recorder started. The delivery of a back-up reinforcer was performed with minimal interaction between *S* and *E*. Before each day's experiment, *S* was taken to the toy room to select enough toys to replace those earned the previous day.

RESULTS

CRF-EXT Subject

The daily session record is presented for this *S* (Fig. 2), because the rate differences for the components are great enough to see clearly in single sessions. (This is not true for the multiple schedules used with the other *S*s, and their daily session records are not presented.) For this *S*, the actual reading program was introduced at point *A* in Session 3. Records prior to this point represent performance on the various pretraining tasks. Point *B* notes the inadvertent reinforcement of a response in the first extinction component. Sessions 4-30 commenced with CRF conditions which then alternated with the EXT condition. At point C the first six responses under EXT were accidentally reinforced. The *S* was removed from the chamber during repairs, the recorder reset, and appropriate EXT conditions were presented to *S*. Point *D* indicates that in Session 18 each EXT component was only of 3 min 20 sec duration.

Figure 2 also shows the operation of the back-up reinforcer system for each session. The event marker on the line below each curve notes the occurrence of a back-up reinforcer: *1* indicates that a 10¢ toy was presented in exchange for 10 marbles, *o* marks the presentation of a 35¢ toy for 35 marbles, and unlettered event marks indicate that *S* deposited a marble for some item from the Universal Feeder. The record thus shows that *S* worked primarily for trinkets and edibles and for low value back-up toys which could be obtained with the marbles received during a single CRF component. In fact, *S* was often observed to place the first 10 marbles received under the CRF condition into the 10¢ tube and to use the remaining marbles for Universal Feeder items.

The record shows (Fig. 2) that the response rate under the two components became somewhat differentiated in Session 6, with responding during EXT generally decreasing across sessions through Session 26. From Sessions 27-30 the EXT rate accelerated. An over-all comparison of the effect of the differing contingencies is obtained when the records for the reading sessions are pieced together by components to give one continuous curve for each reinforcement schedule. This composite record, shown in Fig. 3, indicates that the EXT rate slightly exceeded the CRF rate until *A*, at which point the curves crossed and separated at an ever-increasing pace. A good S^D-S^Δ discrimination was achieved and the child's behavior came under the control of the light stimuli. Unlike the results from more basic studies, however, the child continued to respond to some extent under the S^Δ condition.

The *S* was presented with a total of 1608 reading trials in the experiment. Anticipation data for Session 23 is not available; data recorded for 1565 reading responses shows that

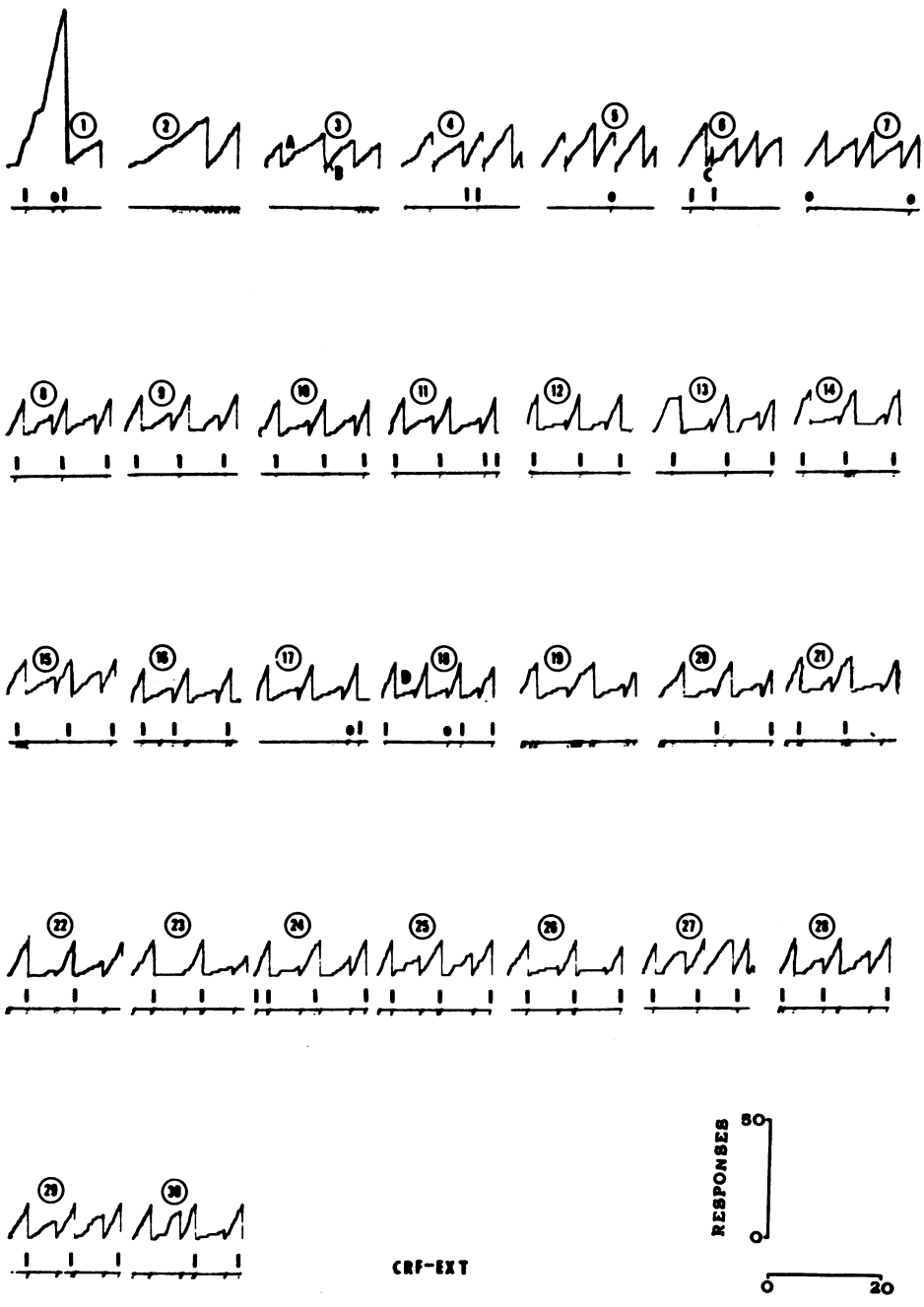

Fig. 2. The 30 daily session records for the *mult* CRF-EXT subject show the reading response rates for the various experimental conditions. Lettered points along the curves refer to procedural changes, some of which are described below and others in the results section. Responses prior to point *A* for this *S* occurred during the pretraining phases of the study. At this point the reading program was introduced under CRF. Beginning with Session 4 each 20-min reading session commenced with a CRF component which then alternated with EXT conditions. The event marker on the line below each record indicates the delivery of a back-up reinforcer: *1* notes the exchange of 10 marbles for a $.10 toy, *o* notes the presentation of a $.35 toy in exchange for 35 marbles, and unlettered event marks indicate the exchange of one marble for an item from the Universal Feeder.

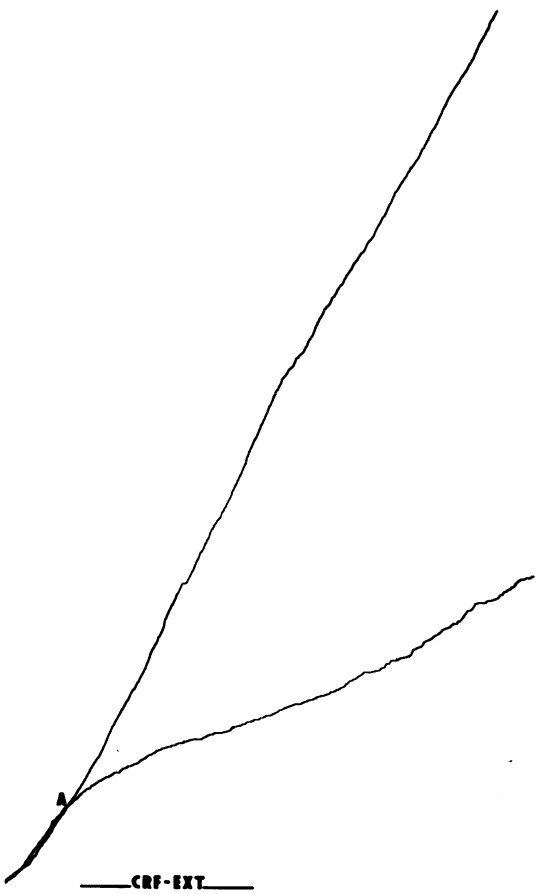

Fig. 3. Composite record for the *mult* CRF-EXT subject. To compare an *S*'s response rates for the two experimental conditions, the records for reinforcement schedules were separated and re-combined to yield an individual curve for each condition according to daily session sequence. All records commence with the introduction of the reading program. The composite records for the four *S*s are directly comparable; however, the size of each record is determined by *S*'s response rate. The figure shows that for the mult CRF-EXT subject the EXT rate was initially the higher rate, but at point *A* it declined and crossed the CRF curve. The CRF response rate was relatively rapid and stable throughout the experiment.

92.20% were anticipated, and 29.65% were anticipated correctly.

CRF-VR Subject

In early sessions this *S* worked primarily for items from the Universal Feeder. Then he began to work toward a 150-marble toy and his response rate increased. Although the curves are not shown, it is interesting to note that a marked reduction in responding was evident in this *S*'s daily record after the delivery of this toy. This type of rate decline was also evident later when the *S* received an 80-marble toy. Overall, this *S* employed the Universal Feeder extensively until the last 10 sessions during which he shifted primarily to 10¢ toys.

The composite curves in Fig. 4 show that in the early reading program sessions the two rates were almost identical, the VR rate beginning slightly below the CRF rate and crossing only at point A. From this point on a higher rate more appropriate to a VR schedule was obtained. CRF component responding remained relatively stable while VR component responding continued to increase across sessions.

By Session 19, *S*'s rate had risen to such an extent that *E* found it difficult to administer manually the reading program promptly in response to *S*'s initiation of each trial. This was especially evident during the VR component. It is possible that a greater difference between the VR and CRF rates would have been shown if the procedure had been automated to a greater extent. In Session 29 the highest number of responses emitted by any *S* in this procedure was obtained during a VR component—92 reading trials in the 20-min session.

The *S* was presented a total of 1519 reading trials during the experiment. Correct anticipation figures for Session 26 were not re-

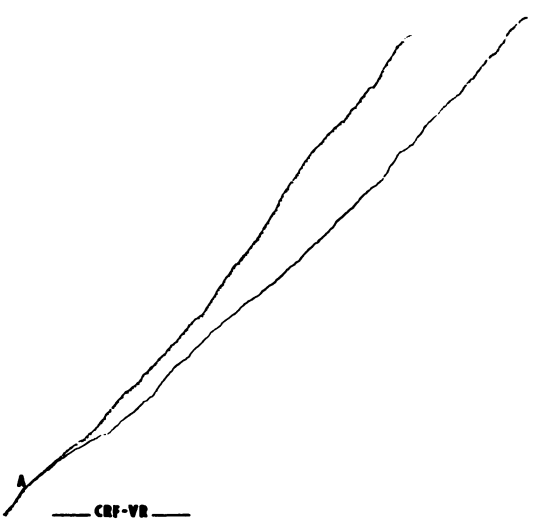

Fig. 4. Composite record for the *mult* CRF-VR subject. The VR curve (shown with slash marks on the record) was initially lower than the CRF curve. However, from point *A* the VR rate is the more rapid.

corded; however, an analysis shows that of 1476 reading trials, 46.14% were anticipated, 43.36% correctly.

CRF-VI Subject

Figure 5 presents the composite curves, indicating the rate differences that developed between the two schedules. Responding during VI components remained essentially at a stable rate throughout—which was initially higher than under CRF. The rate under CRF accelerated after the first quarter of the curve, at which point the CRF rate was higher than the VI. The rates were retained in this relationship and at a point *A* the cumulative records crossed with the CRF, retaining the lead thereafter. Data for Sessions 17-19 do not appear on this record. A special procedure was used during that period to extinguish a "random pecking" type of behavior which had developed.

During the initial session *S* deposited all his marbles for Universal Feeder items. In subsequent sessions *S* used only the tube system. This *S* worked from Session 2 until the latter part of Session 7 without a single back-up reinforcer, and then until Session 10 before receiving another. Response rate decreased after each toy was earned. The value of the back-up toys earned decreased systematically as the sessions progressed; *i.e.*, *S* first deposited his marbles for the highest value toy, then for lesser value toys, and finally only for 10¢ toys.

A total of 1234 reading trials were presented during the experiment, 22.93% of which were anticipated correctly. Data for anticipatory behavior for Sessions 17-30 is not comparable to that of Sessions 3-16 due to the special contingency initiated in Session 17. However, in Sessions 3-16, 581 reading trials occurred, 75.39% of which were anticipated, and 24.96% were anticipated correctly.

VR-VI Subject

The composite curves in Fig. 6 show that response rates for the components were essentially parallel, the VI curve beginning lower than VR until point *A*, then crossing and remaining above the VR curve until point *B*, where the VI rate declines slightly. Thus, differential responding was not controlled by the multiple schedule for this *S*.

The *S* received relatively few reinforcers for reading program sessions during the experiment—an average of 11.40 per session (excluding Sessions 6 and 7). Numbers varied from only 1 in Session 4 to 16 in several later sessions. The *S* worked initially for an 80¢ toy, the receipt of which in Session 9 produced a decline in response rate. He then obtained a number of 35¢ toys. In Session 23, *S* shifted to Universal Feeder items and the over-all rate gradually dropped, accelerating again in the final two sessions during which *S* employed the 10¢ tube.

Anticipatory behavior was extremely weak for this *S*, only seven such responses occurring

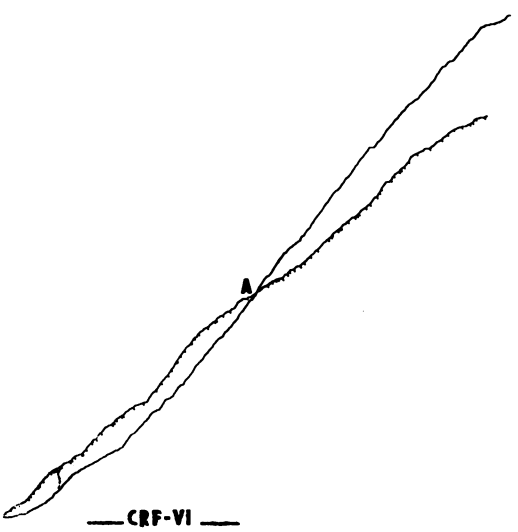

Fig. 5. Composite record for the *mult* CRF-VI subject. The VI curve (with slash marks) is depicted above the CRF curve until point *A* on the record, at which point it becomes the lower.

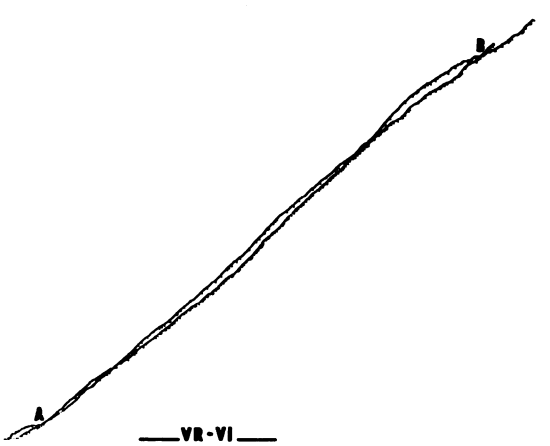

Fig. 6. Composite record for the *mult* VR-VI subject. The VI curve begins lower than the VR curve until point *A*, then crosses and remains above the VR curve until point *B*, at which point the VI rate declines.

even in pretraining. Half of the anticipations to reading material were emitted in Sessions 3-9. Most of the remainder occurred only after prompting by *E*, even though *S* sometimes declared his intention to say them ahead of *E*. Only 1066 reading trials were presented during the experiment, the absence of anticipatory responding requiring the 10-sec delay period on most trials. Of the total responses, 3.56% were anticipated, 2.81% correctly.

DISCUSSION

Several general implications are indicated by the results. First, the principles and techniques of operant conditioning apparently can be extended to the study of significant complex human behaviors—specifically, to the acquisition of reading. The multiple schedule design proved valuable for the study of individual schedule effects and the results were generally as expected on the basis of previous work (*e.g.*, Ferster and Skinner, 1957). However, the differences in rate produced by the different schedules were not as great as are obtainable in more basic studies. This might be expected on the basis of the type of behavior under study. Rather than a quick and easy bar press, knob pull, or pecking response, the present procedure required close discriminations which had to control a chain of motor responses and a class of vocal responses. In addition, this "response" did not take place instantaneously but required more time than is usual. These factors would be expected to dampen the effect of different reinforcement schedules, *e.g.*, in a ratio schedule higher rate "bursts" of responses could not attain startingly more immediate reinforcement because the responses themselves required so much time.

Nevertheless, in each case where a CRF schedule was used as the comparison schedule, the appropriate results occurred. When the opposed schedule was EXT, the discrimination was rapidly acquired and the greatest difference between component schedules of all *S*s was evidenced. Under the CRF-VI schedule the VI component did not produce as high a rate of response as did the CRF. For the CRF-VR subject, on the other hand, the VR schedule produced a rate of response higher than that produced by the CRF.

Only the VR-VI schedule did not produce the expected results—and that appeared to be an artifact of the experimental procedure; *i.e.*, when an *S* did not anticipate there was a 10-sec delay period for the trial. Thus, an *S* who consistently failed to anticipate could attain only the rate limited by this delay procedure, which was the case with the VR-VI subject. Both components of this schedule appeared to maintain the *S*'s behavior at a maximum rate, within the limitation imposed by the lack of anticipation responses. This conclusion is supported by a comparison to an *S* from a previous study who also did not anticipate (Staats, Minke, Finley, Wolf, and Brooks, in press). The *S* in the present study averaged 42.4 responses per training session, whereas the *S* in the previous study, under CRF conditions throughout, averaged 38.7 responses per session. Thus, it is quite possible that under a procedure where the rate is not limited by the 10-sec delay, the expected differences between VR and VI schedules could be obtained, *e.g.*, it would be possible for a VR schedule to result in a more rapid rate of response.

It is also of interest to note that this experiment included conditions which represent one of the few attempts to apply a VR schedule to human behavior. Sidman (1962) states that "Orlando and Bijou (1962) are the only investigators who have reported on this schedule and their work was with developmentally retarded children" (p. 184). Salzinger, *et al.* (1962), have more recently reported an experiment in which speech rate in normal children was subjected to such a schedule.

Although there are improvements to be made in the procedure, and the qualifications already noted, the results of this study indicate that the general procedure and apparatus provide enough experimental control so that the dependent variable (acquisition of reading responses) is sensitive to the manipulation of important independent variables. This suggests that these developments may be extended to the study of a number of types of significant behavior acquisitions, *e.g.*, speech learning, arithmetic learning, *etc.*, and to various special populations, such as deaf children, mutes, mental retardates, *etc.* Much operant research with humans has tended to involve only simple responses such as knob-pulling and button-pressing, and simple controlling stim-

uli. The present facility would seem to be useful in the study of the acquisition of complex responses of more immediate significance to human adjustment. This could also involve work which had remedial objectives, *e.g.*, remedial reading problems, the training of autistic children, general training problems in children resulting from deficient "motivation."

As this discussion implies, in addition to studying the principles of general psychology in the context of this particular type of behavior, other goals of the project are the study of reading itself and the study of child learning in general. Thus, the project is interested in developing an experimental situation which maximizes behavior acquisition, a primary aspect of which is the development of the most efficacious reinforcement system. As noted by other investigators (*e.g.*, Long, Hammack, May, and Campbell, 1958) it has been difficult to develop a reinforcer system which both maintains children's behavior well and is durable, *i.e.*, does not weaken over time. The present reinforcement procedure appears to have solved this problem, but a great deal of study remains in order to maximize the procedure. What is desired is a reinforcement system which will (1) produce maximal rates, and (2) minimize the expenditure of reinforcers. The last stipulation involves both economy as well as the consideration that the fewer reinforcers given, the longer it will take the *S* to satiate on the available reinforcers.

The experimental results which have so far emerged from the laboratory study of reading acquisition have implications for these problems. That is, a number of *S*s have been run under various schedules, both single and multiple. The results are interesting for their effects upon the average over-all rates of behavior produced per session, and for the cost in reinforcers in producing these rates. These effects can be seen by comparing the rates, reinforcers, *etc.*, of the multiple schedule *S*s to each other, as well as to the results of *S*s run in the previous experiment which utilized strictly CRF conditions (Staats, *et al.*, in press). These various results are shown in Table 1.

As can be seen, the highest average rate per session was produced under CRF-EXT; the next highest, in order, were CRF-VR, CRF-VI, VR-VI, and then the CRF subjects. On the other hand, the VR-VI schedule involved the least expenditure of reinforcers. The CRF-VI and CRF-VR schedules involved about an equal frequency of reinforcement and yet the rates produced were higher for the latter, as would be expected. While the CRF-EXT schedule produced the highest average number of responses per session, the percentage of reinforcement for the responses was also high. Nevertheless, it is interesting to note that the highest CRF rate of any *S* (including the straight CRF subjects) was produced when this schedule was paired with extinction. This finding would be expected from Reynolds (1961a, 1961b) study of the relationship of reinforcement frequency and behavioral contrast.

These data and the comparisons must be considered to be tentative since, as a consequence of the experimental procedure, rate was not independent of the number of anticipations *S* made. An anticipation, correct or incorrect, obviated the 10-sec delay period. Thus, *S*s who made many anticipations were afforded the opportunity of moving more rapidly. It is also true that any individual differences in rates were not controlled in these comparisons, since only one *S* was run under each multiple schedule. Nevertheless, in broad outline, the results seem to contain some information. For example, the three CRF subjects appeared to produce highly similar rates. In addition, the results indicate that the multiple schedules which involve intermittent reinforcement generally produced higher rates for less expenditure of reinforcers than did CRF—a very important finding in this situation for both practical and scientific purposes.

As Herrnstein and Brady (1958) point out, the effects of schedules upon behavior can be studied in a short time through the use of multiple schedules. However, there appears to be an interaction between the components of a multiple schedule (see also Reynolds, 1961a, 1961b). This is a limiting factor in generalizing the effects of a component in a multiple schedule to its effects in isolation. As a consequence, there has been interest in studying the effects of interaction on the individual component. However, the effects of interaction upon the over-all rates produced under multiple schedules (as well as other types of combinations) have not yet been systematically studied. (See Herrick, Myers,

Table 1

Comparison of Performance of Subjects Run Under Different Schedules of Reinforcement*

Subject	*Sessions*		*Total Responses*	*Average Responses/ Session*	*Average Tokens/ Session*	*Average Responses/ Token*	*% Responses Reinforced*	*% Total Anticipations*	*% Correct Anticipations*
	Whole Days on Reading	*Total for Computations*							
CRF #1	4-11	8	294	36.7	36.7	1.00	100	76.4	40.5
CRF #2	3-40	38	1473	38.7	38.7	1.00	100	2.3	2.1
CRF #3	3-40	38	1305	34.5	34.5	1.00	100	47.4	45.3
CRF-EXT	4-30 less session 23	26	1530	58.8	44.5	1.32	75.6	94.0	30.1
CRF-VR	5-30	26	1394	53.6	34.5	1.56	64.3	50.0**	46.9**
CRF-VI	4-30 less sessions 17-19	24	1075	44.8	29.3	1.53	65.4	75.7***	25.0***
VR-VI	4-30 less sessions 6-7	25	1060	42.4	11.4	3.72	26.9	3.6	2.8

*Results of seven *Ss* run in this laboratory facility. Subjects CRF #1, #2, and #3 were employed in a procedure comparable to the present study, but were administered only continuous reinforcement conditions (see Staats, Minke, Finley, Wolf, and Brooks, in press). Computations are based on full-length reading sessions; sessions omitted include pretraining phases, major deviations from normal procedure, or sessions for which complete data were unavailable.

**Session 26 omitted.

***Sessions 17-30 omitted.

and Korotkin, 1959, for an indication that over-all rates of response under an S^D-S^Δ multiple schedule may be greater than under CRF.) The tentative suggestion which has emerged from the laboratory study of reading acquisition to date is that multiple schedules can also have significance in terms of maximizing rates of response produced in the individual components and thus result in higher over-all rates. At the same time, multiple schedules may also offer the possibility to reduce the expenditure of reinforcers. This is important in the study of human learning, where the reinforcer system may be a problem.

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